Health Consultation

Everett Landfill
Snohomish County, Washington
CERCLIS #WAD980639405

October 13, 2000

Prepared by
The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The health consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substances. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

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Glossary

Acute
Occurring over a short period of time. An acute exposure is one which lasts for less than 2 weeks.

Agency for Toxic Substances and Disease Registry (ATSDR)
The principal federal pubic health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.

Chronic
A long period of time. A chronic exposure is one which lasts for a year or longer.

Contaminant
Any chemical that exists in the environment or living organisms that is not normally found there.

U.S. Environmental Protection Agency (EPA)

Established in 1970 to bring together parts of various government agencies involved with the control of pollution.

Exposure
Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long-term (chronic).

Groundwater
Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.

Hazardous Substance
Any material that poses a threat to public health and/or the environment. Hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.

Model Toxics Control Act (MTCA)

The hazardous waste cleanup law for Washington State.

Organic
Compounds composed of carbon, including materials such as solvents, oils, and pesticides which are not easily dissolved in water.

Parts per billion (ppb)/Parts per million (ppm)

Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.

Indeterminate public health hazard
Sites for which no conclusions about public health hazard can be made because data are lacking.

Background and Statement of Issues

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the Washington State Department of Ecology (Ecology) for technical assistance to discuss the feasibility and/or evaluate and establish recommended criteria for development over the Everett Landfill. This includes providing comments on health and safety aspects of the Brownfield Feasibility Study. Ecology, with the City of Everett's assistance, is working to develop a Cleanup Action Plan for final remedial action at the Everett Landfill.[1]

The Comprehensive Plan and Shoreline Planning processes at the City of Everett have designated the landfill property as an area targeted for redevelopment. The City's Shoreline/Brownfields Committee has recently proposed a draft vision statement which envisions high quality/master planned development. Mixed uses on the site may include commercial/retail, office, multi-family residential and public access. Brownfield Feasibility Study documents assume that development at the site may be similar in nature to the University Village Shopping Center in Seattle, Washington.[2] This could include approximately 600,000 square feet of retail space in addition to landscaping, parking, walkways, and utility infrastructure, with both one and two-story structures. Additionally, the potential for construction of "big box" structures was considered.

The Everett Landfill was established in 1917. It later became the primary municipal and commercial solid waste disposal site for the Everett area starting in the 1950s until 1966.[3] It is located east of the Everett business district at 2902 36th Street East, Everett, Washington. The landfill borders the Burlington Northern Santa Fe (BNSF) railroad and the Snohomish River on the east side, BNSF the to the west, 36th Street is to the north, and the old Simpson mill to the south (see Figure 1). The landfill surface covers 70 acres and slopes gradually to the south. The eastern edge drops off sharply down a 20-foot embankment into a drainage ditch, which connects to the Snohomish River. Groundwater depth is approximately 14 feet below the original ground surface. The surface of the landfill is approximately 17-25 feet above the original elevation.[2]

The landfill was filled with domestic waste, construction debris, automobiles, tires, and other unknown materials. In 1970, 22,000 gallons of waste oil, oil sludge, and spent chemicals were illegally disposed of into the landfill.[3] It was reported in 1969, that approximately 200,000 gallons or 800-900 tons per year, of oil and chemicals were being accepted by the landfill for disposal.[3]

After final placement of fill material in the southern end of the site, the landfill was closed in 1974.[3] This area was covered with a 12-inch clay cap and graded in 1975. In 1977 the city of Everett leased the area to a private company for chipping used rubber tires for boiler fuel.

From 1983 through 1985, two fires consumed approximately one million tires over 5.6 acres.[3] The area of the largest and longest burning fire (approximately 15 months) is now covered with approximately 10 inches of ash mixed with wire fragments and partially burned tires (Figure 2). Analysis has shown the ash to contain an average of 5.0 ppm of polycyclic aromatic hydrocarbons (PAHs) and seven percent heavy metals of which 99 percent is zinc and zinc compounds.

Under Ecology direction following the tire fires, the City has conducted numerous environmental investigations and analyses and has performed several interim cleanup actions. Ecology also provided oversight and approval and further testing of the tire fire ash to designate the classification of the waste. Results of the 1992 testing indicated that the tire fire ash was a non-dangerous waste and classified as a solid waste. In 1995, the City performed the site's first Interim Action, "Everett Landfill Site Grading," which added capping material and regraded the entire site except for the two tire fire areas to allow the collection of surface water and to reduce leachate generation. The second Interim Action occurred in 1997 and 1998 with the installation of a leachate collection trench and transmission system. As approved by Ecology, this project removed the remaining tire fire ash on the surface of the site and disposed the material onsite and covered with 4-feet of clean soil. The project also provided a geomembrane cover on the eastern side slopes of the landfill to control leachate seeps, site fencing, site cover and control of water on the eastern portion of the site and removal off-site of remaining tires. The City also conducted an independent action removing one to two feet of debris and soil from the East Ditch to address debris and potential sediment contamination in the ditch. Excavated material from the East Ditch was placed within the landfill and covered with four feet of clean soil.

There are two buildings on-site - an animal shelter operated by the city of Everett, and the lunchroom of the recycling and transfer station leased and operated by Snohomish County (Figure 3). These buildings have gas monitoring and alarm systems. Currently, there are no active or passive gas collection and treatment systems; however, an active gas collection system has been proposed by the city of Everett to support future development.

Characteristics of Landfill Gas

In order to discuss the feasibility of building over an existing landfill, the characteristics and hazards of landfill gas must be considered.

Landfill gas is composed of a mixture of different gases. By volume, landfill gas is composed of about 50% carbon dioxide and 50% methane.[4] Landfill gas also contains a smaller percentage of nitrogen, oxygen, ammonia, sulfides, hydrogen, carbon monoxide, and nonmethane organic compounds (NMOCs), such as trichloroethylene, benzene, and vinyl chloride. Landfill gas is produced by three processes - bacterial decomposition, volatilization, and chemical reactions. The rate and volume of landfill gas produced at a specific site depend on the composition and age of the refuse, and the presence of oxygen in the landfill, moisture content, and temperature.

Landfill gas expands to fill whatever space is available.[4] Once gas is produced in a landfill, it begins to move, or "migrate." The movement of landfill gas creates health and safety concerns when the gas enters buildings and other confined areas such as utility corridors. Methane is the constituent of landfill gas that is likely to pose the greatest explosion hazard. Since methane is lighter than air, it has a natural tendency to move upward, and eventually out of the landfill surface. Densely compacted waste or a landfill cap can inhibit upward movement of landfill gas. When upward movement is inhibited, the gas tends to migrate horizontally to other areas within the landfill or to areas outside the landfill where it can resume its upward path. Other gases, such as carbon dioxide, are denser than air and can collect in subsurface areas, such as utility corridors.

As indicated above, the disposal methods and landfill construction can influence the movement of landfill gases. The changes in disposal methods and waste materials over the active disposal period of a landfill also affect the composition and generation of landfill gases. Landfills that contain significant amounts of construction debris such as gypsum boards tend to generate more hydrogen sulfide gases than landfills with only vegetative (tree stumps and yard trimmings) wastes. Landfills that disposed liquid chemical wastes in separate areas from sanitary wastes tend to produce higher concentrations of non-methane organic chemicals over the liquid waste disposal areas than over the sanitary wastes.

Age and disposal history generate significant differences in landfill gas generation and movement within the landfill. Sanitary and vegetative wastes disposed in the oldest portion of a landfill may be past peak landfill gas production while wastes disposed immediately before closure may not have reached peak production rates. It has been over 25 years since the Everett Landfill received any refuse. Current landfill gas production is approximately a third of its peak production (which occurred 20 years ago) and continues to decline over time.

The concentration and movement of landfill gas can change rapidly (in a matter of hours) in response to changes in atmospheric and subsurface conditions. Higher atmospheric pressures can inhibit upward movement of landfill gases. Rainfall can saturate pore spaces in surface soils thereby reducing vertical movement and increasing horizontal movement. Rising flood waters in adjacent rivers or daily tidal fluctuations in adjacent estuaries may cause temporary rise in water table levels, displacing landfill gases upward and outward. Infrequent monitoring of landfill gases may miss such rapid changes or lead to misinterpretations of site specific conditions.

The concentration level at which gas has the potential to explode is called the explosive limit. The potential for a gas to explode is determined by the lower explosive limit (LEL) and upper explosive limit (UEL). The LEL and UEL are measures of the percent of a gas in the air by volume. At concentrations below its LEL (5% methane by volume) and above its UEL (15% methane by volume), a gas is not explosive. However, an explosion hazard may exist if a gas is present in the air between the LEL and UEL and an ignition source is present.

Landfill Gas Conditions at Everett Landfill

The current landfill gas activity has been estimated based on the age and volume of solid waste at the Everett Landfill.[5] An estimated volume of 1,820,000 cubic yards of decomposable solid waste has been in place since 1974. The landfill gas estimate for 2000 is 230 cubic feet per minute (cfm) for the entire landfill, or about three cfm per acre. At closure in 1975, the landfill gas volume estimate was 625 cfm. Present gas volume is therefore approximately 37% of its peak, and predicts approximately 7.5 cfm annual reduction in gas generation over the next 10 years, such that in 2010 landfill gas generation is estimated to be 155 cfm.

In May of 1999, the highest detected level of methane in the air on the landfill surface was 7,600 ppm (0.76% by volume), which is less than the LEL of 50,000 ppm (5% by volume).[5] The highest detected level of methane below the surface of the landfill was 100% by volume, at landfill gas monitoring well LG-9B, and the highest detected level of hydrogen sulfide gas in the landfill was 93 ug/m3, at landfill gas monitoring well LG-8 (Figure 3).

The highest detected levels of methane in the animal shelter and the lunchroom (the two structures on-site) was 7,800 ppm (0.78%) and 200 ppm (0.02%), respectively. Repairs and subsequent monitoring at the Animal Shelter have reduced readings to non-detect levels. The lower explosive limit (LEL) for methane in air is less than 5.53%, the point at which the mixture of air and methane will not explode. While these measured levels are below the LEL for methane, landfill gas concentrations are extremely variable and difficult to predict. Thus far, eight stations within the interior of the landfill have been sampled (some at multiple depths) for methane, carbon dioxide, vinyl chloride, hydrogen sulfide and oxygen (Table 1).

The methane sampling results from temporary ~~on~~ (off) site probes (Appendix K of the Brownfield Feasibility Study) do not include results for carbon dioxide and oxygen. Therefore the effects of poorly sealed wells or leaking sampling equipment cannot be validated. The sampling methods used (evacuating 5 times well volume before measurements) are more likely to produce lower concentrations than sampling protocols that stress initial readings and stabilized readings.

As indicated on page 5-23 of the Brownfield Feasibility Study, the extent and magnitude of subsurface landfill gas migration has not been fully determined. The City of Everett is working with Ecology to mitigate and monitor the potential for off-(property) ~~site~~, subsurface migration of landfill gases.

Table 1
Maximum and Average Gas Concentrations Detected in Landfill Interior Between 1995 and 2000

MW Boring	Range of Screened Depth	Methane percent		Carbon Dioxide percent		Vinyl Chloride ug/m^3		Hydrogen Sulfide ug/m^3		Oxygen percent	
		max.	ave.	max.	ave.	max.	ave.	max.	ave.	max.	ave.
LG-3a	7-12	87.5	55.8	3.3	2.9	340	320	0.0	0.0	0.5	0.2
LG-3b	15-20	79.2	46.4	3.5	2.6	67	54	0.0	0.0	20.5	2.2
LG-4a	8-11	92.5	81.5	18.8	14.5	360	325	26	16.6	2.1	0.4
LG-4b	13-16	95	75.7	17	12.9	144	96	15	8.0	5.2	0.5
LG-5a	3-6	66.5	62.5	44.2	48.7	240	97	23	17.6	0.5	0.1
LG-6a	5-10	67	62.5	60.6	49.7	169	87	55	30.3	0.4	0.2
LG-7a	7-12	72.4	67.5	51.5	42.4	39	36	16	13.4	1.0	0.1
LG-7b	15-20	73.8	64.9	49.5	39.5	217	137	15	11.2	0.5	0.0
LG-8	5-8	75.1	66.1	29.9	46.4	110	65	93	74.5	0.3	0.0
LG-9a	4-9	26.2	5.7	1.6	1.6	N/C	N/C	N/C	N/C	15.7	15.7
LG-9b	12-17	100	89.9	2.3	2.3	578	446	0.0	0.0	0.1	0.0
LG-9c	20-25	98	81.7	3.4	3.3	200	200	0.0	0.0	0.0	0.0
LG-10a	4-9	98.3	92.8	3.1	2.8	110	110	0.0	0.0	0.0	0.0
LG-10b	11-16	93.6	76.5	3.4	2.4	258	258	0.0	0.0	0.0	0.0
LG-10c	18-23	95.3	79.3	1.6	1.3	185	185	0.0	0.0	0.0	0.0

N/C: Data not collected

Feasibility of Development Over a Landfill

Building on a landfill increases the possibility of infiltration of flammable or toxic gases which increases the safety risks of inhalation of toxic gases or fire or explosions, and requires special engineering and monitoring to compensate for these risks.

The perimeter of the Everett Landfill appears to have been adequately characterized with respect to landfill gases, while some areas of the interior have been partially characterized. Therefore, it is difficult to accurately address the type and extent of problems that could occur with the landfill's current condition. To lessen the risk of inhalation of toxic gases and fire or explosions, the proposed development by the City of Everett includes an active gas accumulation system as well as monitoring, and if necessary, treatment or burn off of landfill gases. Ecology is working with the City of Everett to define requirements for such special engineering and monitoring that would be needed both for existing conditions and potential future development. Those requirements should address the risks described in this report, and should take into account the variable nature of landfill gas characteristics and constituents.

Inhalation of Landfill Gas

One of the concerns at the Everett Landfill is landfill gas. Landfill gas emissions are regulated by the Washington State Department of Ecology, Model Toxics Control Act (MTCA).[5] The contributions of landfill gas from the Everett Landfill to ambient levels cannot exceed cleanup standards established under MTCA. Cleanup levels are a means for ensuring that emissions from specific sources do not result in acute or chronic toxic effects on human health.

With respect to inhalation of landfill gas, the severity of adverse health effects depends on the composition of gas, concentration, and duration of inhalation. As previously indicated, landfill gases are composed of a mixture of gases. Methane and carbon dioxide are generally not considered to be toxic gases in that they would become asphyxiates long before becoming toxic. While methane and carbon dioxide dominate the mixture, the other gases are not insignificant. As an example, methane and carbon dioxide do not produce the strong, sometimes nauseating, odors associated with landfill gases. Landfill gas odors are produced by the mixtures of sulfides, ammonia, and other gases.

Odors can cause symptoms such as headaches or nausea. Typically, these effects are reversed when the odor is eliminated. Discussed below are potential sources of landfill odors including sulfides, ammonia, and certain NMOCs. Limited data are currently available on these types of gases at the Everett Landfill.

Hydrogen sulfide, dimethyl sulfide, and mercaptans are the three most common sulfides responsible for landfill odors.[4] These gases produce a strong rotten egg smell - even at low concentrations. Of these three, hydrogen sulfide is the most common and typically has the highest concentration at landfills. Humans are extremely sensitive to hydrogen sulfide and can smell it at concentrations as low as one part per billion (ppb). Average concentrations in ambient air range from 0.11 to 0.33 ppb. Typical concentrations of hydrogen sulfide in air around a landfill is usually about 15 ppb.

Ammonia is another odorous landfill gas that is produced by the decomposition of organic matter in the landfill. Ammonia is common in the environment with the breakdown of manure, and dead plants and animals. Because ammonia is commonly used as a household cleaner, most people are familiar with its sharp smell. Landfill gas has been reported to contain between 1,000 and 10,000 ppm of ammonia, or 0.1% to 1% ammonia in air. Concentrations in ambient air at or near a landfill are expected to be much lower.[4]

Nonmethane organic compounds (NMOCs), such as ~~vinyl chloride~~ mercaptans, chlorinated organics, and hydrocarbons, may also cause odors; however, NMOCs are generally produced at very low concentrations.[4] Little is known about the health effects associated with exposure to NMOCs. The health effects of NMOCs are normally evaluated on a chemical-by-chemical basis. Potential health effects from long-term exposures to low levels of landfill gases released to ambient air are not easy to evaluate, largely because exposure data are often lacking. Ecology and the City of Everett should ensure that gas management requirements proposed for the site address the potential risks of landfill gas inhalation, and take into account the variable nature of landfill gas characteristics and constituents.

Fires or Explosions

In the case of methane, if allowed to accumulate to concentrations between 5% and 15% by volume, it is flammable. If methane is confined in an enclosed space, it may be explosive if ignited.[5] Methane gas beneath the landfill is not explosive because there is insufficient oxygen present to support combustion and there is no ignition source. Methane gas is also not typically explosive when released to the atmosphere because of the immediate dilution. However, if released into a confined space such as a building crawl space or storage room without ventilation, methane could reach an explosive concentration. In addition to explosiveness is flammability. If a post or pole is used to puncture the surface of a landfill, the small voids could act as a small vent where methane collects and discharges out the top. If an ignition source were provided, it could ignite and burn. There have been numerous examples of problems created by sites where risks have not been anticipated and addressed with institutional and engineering controls.

In 1999, a child playing on a slide in a municipal park in Georgia was seriously burnt by inadvertent ignition of landfill gases. The playground was unknowingly built over an abandoned and covered dump. The playground included swing sets and slides with frames made of hollow piping material which penetrated the clayey soil covering the waste material. Environmental investigators theorized that over time, the pipes filled with landfill gas. When the little girl slid down one of the slides, investigators theorized she generated static electricity, which ignited the gas and caused an explosion and flare-up, which burnt the child's arm.[6] Environmental investigations following the injury revealed flammable levels of methane beneath the playground.

Other closed landfills have had subsurface fires occur and produced noxious gases for many months.[7] Subsurface landfill fires are extremely difficult to extinguish because of the almost inexhaustible supply of flammable gas and lack of direct access by conventional fire-fighting equipment. For example, a landfill on a South Pacific island has a history of accepting municipal, industrial, and medical wastes and debris from construction activities and hurricanes. An underground fire at the landfill emits combustion byproducts through fissures in the landfill surface. The underground fire also breaks through the surface occasionally and covers the island with black smoke.

Additional examples of landfill gas explosions or fires, which have caused fatalities, have been documented by the US Environmental Protection Agency and the US Army Corps of Engineers.[8] Environmental and public health problems are often discovered many years after landfill closure. For example, a landfill in Southington, CT was closed in 1967, then subdivided and developed into commercial, industrial and residential properties. An environmental investigation in the 1990s revealed flammable levels of landfill gases entering buildings on-site. The local government and other responsible parties paid to relocate residents and businesses, as well as to remediate the contamination problems.[9]

The examples listed above illustrate the importance of the work that is being conducted by Ecology and the City of Everett under the Model Toxics Control Act to define requirements that will be stringently enforced for any future construction on the landfill site. Construction must include appropriate landfill gas management controls that will be operated in perpetuity.

Subsidence

One of the concerns with building over a closed landfill is the possibility of subsidence or sinkholes. As an example, a problem with subsidence occurred in New Orleans when the city planners engineered low cost housing and a middle school over a closed landfill. Over time, the foundation of the school cracked and broke in many places, and eventually had to be abandoned.[10]

Another concern is uneven subsidence causing stress or breakage of underground utilities. Unless underground utilities are engineered properly, uneven subsidence could cause a breakage in buried electrical conduits which may create an electrical hazard, and/or cause sparks to an adjacent broken natural gas (utility) line and cause an explosion.

Cracks in foundations, flooring, and drainage pipes in a building provide a potential pathway for landfill gas migration into the buildings. Without adequate monitoring and ventilation (external and internal) flammable levels of landfill gases could accumulate in confined areas of the buildings such as utility rooms and furnace rooms.

Generally, physical hazards could result in people receiving physical injuries from a wide variety of objects, such as jagged pavement, rusty nails in lumber, broken glass, or scrap metal.

In regard to the Everett Landfill development, the City of Everett proposes to build structure foundations on pilings through the landfill, to the original ground surface. In addition, flexible underground utilities and connections are proposed to compensate for uneven subsidence.

Child Health Initiative

The Agency for Toxic Substances and Disease Registry and DOH recognize that children are especially vulnerable to environmental contamination such as the landfill gases at the Everett Landfill. The potential for exposure and subsequent adverse health effects is often increased for young children as opposed to older children or adults. Young children often receive higher doses of toxic substances by body weight. In addition, since they are shorter, they are closer to sources of toxic substances, such as landfill gases, that are closer to the ground. In addition to the potential for higher exposures of young children, the risk of adverse health effects is also increased. ATSDR and DOH recognize that young children are susceptible to developmental toxicity that can occur at exposure levels much lower than those causing toxicity in older children and adults.

Conclusions

- With respect to the current condition of the landfill, ~~gases, the perimeter of the Everett Landfill appears to have been adequately characterized,~~ while the landfill has been partially characterized, the landfill is fenced and generally inaccessible to the public. In addition, indoor air monitoring of the two on-site buildings indicate that landfill gas has not been at levels of public health concern. Therefore, there is currently no apparent public health hazard. ~~characterized; therefore, it is difficult to make an accurate health determination, hence an indeterminate public health hazard currently exists.~~ While health hazards related to landfill currently may exist, both the Department of Ecology and the Puget Sound Clean Air Authority have regulatory jurisdiction over the site. In working with the City of Everett, these regulatory agencies should ensure that controls are defined for the site which adequately protect site users and surrounding areas in both existing and future site conditions - from risks associated with landfill gas constituents and subsidence.

- With respect to future development over the Everett Landfill, there are three potential human health hazards: gas accumulation causing the potential for explosions or fires, an inhalation hazard to odorous and non-odorous (NMOCs) gases, and the possibility of physical hazards caused by subsidence from underground voids or non-compacted waste. Building on a landfill increases the possibility of infiltration of flammable or toxic gases which increases the safety risks of inhalation of toxic gases or fire or explosions, and requires special engineering and monitoring to compensate for these risks. However, the city of Everett proposes to mitigate these risks with a landfill gas monitoring system, as well as an active gas collection system for landfill gases that will include treatment and/or controlled discharge of collected gas as necessary to meet regulatory requirements. In addition, to prevent subsidence, the city of Everett proposes to extend structure foundations on pilings through the landfill, to the original ground surface. Also, special engineering will be used for underground utilities to compensate for uneven subsidence.

Recommendations and Public Health Action Plan

- Based on current information with respect to development over other landfills, special engineering and monitoring is recommended to compensate for increased risks of inhalation of toxic gases, fire or explosions from flammable gases, and physical hazards caused by uneven subsidence. This should include, but not be limited to, an active gas collection system for landfill gas management with appropriate permitting requirements, maintenance and monitoring requirements to ensure effective operations over time. If a gas burn off system is determined to be necessary, continuous gas monitoring of raw and combusted gas for odorous and non-odorous gases should be conducted. The landfill development must be engineered and constructed in such a way as to prevent building subsidence or lessen the integrity of the landfill surface barrier and underground utilities. A contingency plan should be developed for emergency response and evacuation during construction and long-term perpetual care and maintenance. Indoor explosive gas monitors should be installed and maintained in all buildings constructed on the landfill. Prior to constructing and occupying on-site buildings, developers and building owners should sign legally binding documents agreeing to proper monitoring and maintenance of engineering controls and safety contingency actions to prevent injuries and illness from landfill gases. Other institutional controls should be implemented to reflect the potential hazards on land titles and deeds.

- DOH would like the opportunity to review proposals to construct and occupy childcare and/or long-term care (for elderly or chronically ill people) facilities, schools, or playgrounds on the Everett Landfill.

Public Health Action Plan

DOH intends to review upcoming environmental monitoring data and plans for future development of this area. Copies of this health consultation and future recommendations will be provided to the City of Everett, Ecology, Snohomish Health District, and made available to citizens of the City of Everett and surrounding areas.

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Appendix

Insert Figure 1

Insert Figure 2

Insert Figure 3

Certification

This Everett Landfill Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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